MEMORANDUM

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To: Ryan Miya, DTSC

From: Bridgette DeShields
Kris Fabian, P.E.
Judy Nedoff

Re: Backfill/Cap Design for Foundation Removal Areas

Date: Original: August 22, 2006
Revised: September 8, 2006

cc:
Ms. Denise Tsuji, DTSC
Mr. Craig Hunt, RWQCB
Ms. Linda Ruffing, City of Fort Bragg
Nancy Atkinson, City of Fort Bragg
Mr. James Baskin, California Coastal Commission
Mr. Al Wanger, California Coastal Commission
Mr. Glenn Young, Fugro West, Inc.
Mr. Mark Stelljes, SLR International Corp.
Ms. Carol Stephens, Georgia-Pacific Corporation
Mr. Paul Montney, Georgia-Pacific Corporation
Mr. Stewart Holm, Georgia-Pacific Corporation
Mr. Doug Heitmeyer, Georgia-Pacific Corporation

This memorandum describes the proposed methods and design specifications for backfilling/capping the foundation removal areas at the former Georgia Pacific Corporation (G-P) California Wood Products Manufacturing Facility, 90 West Redwood Avenue, Fort Bragg, California (site). This memorandum has been revised based on informal comments from the Department of Toxic Substances Control (DTSC) and the Regional Water Quality Control Board (RWQCB).

BACKGROUND

In the March 28, 2006 letter from Acton Mickelson Environmental, Inc. (*Clarification and Modification to Work Plan for Foundation Removal, Additional Investigation, and Interim Remedial Measures Dated March 21, 2005, Addenda #1 and #2 to the Work Plan for Foundation Removal, Additional Investigation, and Interim Remedial Measures Dated May 6 and August 19, 2005, Respectively, and Response to RWQCB Comments Dated July 18, 2005*), the following discussion regarding backfilling/capping of the foundation areas was presented:

> "Interim capping will be implemented in foundation-removal/impacted soil excavation areas anticipated to require remedial action during the final remedial phase. The interim cap will be designed to mitigate potential transport of the detected constituents of potential concern (COPCs) during this limited time period. Specifications regarding the type, design, and implementation of the interim cap cannot be defined at this time due to uncertainty regarding the physical and chemical conditions in these potential areas. Low permeability caps that may be considered in potentially impacted areas include:
>
> - Fine-grained materials (e.g., clay or silt)
> - Asphalt
> - Concrete
> - Geomembrane material.

The final selection, design, and implementation of all interim caps at the site will be made with the concurrence of the RWQCB."

PURPOSE OF BACKFILLING/CAPPING

Excavation areas, opened up as part of foundation removal, need to be backfilled/capped to:

- Bring the areas back to grade according to requirements of the City of Fort Bragg Grading Permit;
- Facilitate site surface drainage; and
- Reduce health and safety hazard on the site.

and, where COPCs are left in place that may require future remedial action:

- Reduce the possibility of migration of contaminants that may be present in soil and/or groundwater under the former foundations until the site investigation is completed, there is a comprehensive understanding of the nature and extent of subsurface contamination, and a remedial action concept is developed.

Initially, interim remedial measures (IRMs) were planned to be implemented to remove obviously impacted soils (i.e., soils with chemicals concentrations above screening levels). However, IRMs are not proposed to be implemented this year due to the short time available for agency review, approval, and implementation before the close of the construction season (October 15) based on the Coastal Development Permit (CDP) conditions. Therefore, there are two types of areas where caps will be required for foundation removal areas:

1. Areas where sampling adjacent to and beneath the former foundations showed acceptable levels of COPCs could also be backfilled with clean, suitable soils; and
2. Areas where remedial measures may be required in the future would require an "interim cap" as described above from AME's March 28, 2006 memorandum.

Given the current schedule for completion of the current phase of the foundation removal project and the transition of the project to the DTSC, G-P has elected to interim cap all areas.

CAPPING DESIGN

The following provides the proposed "interim cap" designs for areas that are dry and those where groundwater is daylighting. Both designs incorporate a geomembrane. The areas that are inundated with water (Powerhouse and a portion of the Sawmill; see attached photos) are more challenging. Since soils present in those areas are already in contact with groundwater, the main purpose of the cap to prevent any additional infiltration to and runoff from these areas.

For capping in dry areas, i.e., areas where groundwater is not likely to extend to the bottom of the excavations, the interim cap will consist of the following:

- geosynthetic clay liner (Bentofix EC[1] or equivalent) laid on the bottom of the excavation overlain by;
- clean inert material filled and compacted in the excavation area to grade; and

[1] http://www.gseworld.com/Products/gcls/bentofix/bentofix.htm?DS044ec
[2] www.gseworld.com/Products/nw-geotextiles/PDFDOC/AP029Geotext.pdf#search=%22geotextile%20NW8%22

- filled slightly above existing surface and graded to promote runoff from the interim cap
- revegetate with a native seed mix.

The geosynthetic clay liner will provide a relatively thin (4-6 millimeters [mm]) low permeability barrier between the foundation soils and overlying clean fill; it will also provide a marker layer. Note that all foundation excavations will be surveyed by a licensed surveyor prior to backfilling/capping.

For capping in wet areas, i.e., areas where groundwater is likely to extend to the bottom of the excavations, the interim cap will consist of the following:

- geotextile (nonwoven needle punched geotextile: GSE NW8[2] or equivalent) laid on the bottom of the excavation overlain by;
- crushed rock/crushed concrete rubble (1 to 4 inches) filled and lightly compacted in the excavation area to grade;
- filled slightly above existing surface and graded to promote runoff from the interim cap; and
- covered with a geosynthetic clay liner (Bentofix EC or equivalent), which is then
- covered with minimum 12 inch of lightly compacted clean inert fill.

The geotextile will be semi-permeable, allowing groundwater to percolate through thus reducing the potential of the build up of excess pore pressure; it will, however, provide a marker layer and provide some resistance to any contaminant migration. The geosynthetic clay liner will provide an isolation layer to prevent the percolation of precipitation into the footing excavation.

Typical cross-sections of both the dry and wet interim cap designs are shown on Figure 1. Specifications for the geotextile (Section 02311 – Geotextile) and for the geosynthetic clay liner (Section 02312 – Geosynthetic Clay Liner) are also attached (Attachment A).

The backfill material on top of each area would also need to support revegetation with native plants (as required by the CDP) or a layer of topsoil would need to be used that would support native plants. According to the CDP and provision of the City of Fort Bragg (grading) permit:

> "Following completion of the excavation, all areas that are excavated or otherwise left with exposed soils shall be revegetated with native plant species.,. The permittee shall provide irrigation, maintenance and replacement of revegetated areas, as needed, to ensure the long-term viability of the plants."

G-P is utilizing a qualified local botanist to design the revegetation program. Additional details on the revegetation and placement of topsoil (if deemed necessary) are provided in Attachment B.

Caps in all three areas require the use of suitable, clean backfill. Backfill would need to have concentrations of chemicals below conservative screening levels (e.g., California Human Health Screening Levels [CHHSLs; http://www.calepa.ca.gov/Brownfields/documents/2005/CHHSLsGuide.pdf] or USEPA Region IX Preliminary Remediation Goals [PRGs; http://www.epa.gov/region09/waste/sfund/prg/index.html]).

BBL is currently securing a source of clean fill/soil. The likely source is stockpiled dredged material from Noyo Harbor. Full analytical data for this material is provided in Attachment C and Table 1 provides a comparison of this data to the screening levels listed above. The material appears suitable for use as clean backfill. This material as been used as a borrow source elsewhere (e.g., by CalTrans), and the material was

previously approved by the dredging agencies (USEPA, Corps of Engineers, RWQCB) for upland placement. BBL tested the salt content of this material to ensure that vegetation can grow on it and it appears suitable. If necessary, the material will be amended or a top soil, which would be obtained from a landscape supply and thus certified clean, will be brought in. Other sources of clean fill and topsoil are being explored. If other sources of fill are identified, the data will be sent to DTSC prior to implementation.

Only clean concrete (with concentrations of chemicals below conservative screening levels) will be crushed and reused as backfill. BBL will be providing DTSC with a separate memorandum on the analytical data for stockpiled concrete.

Attachments:

Table 1 – Dredged Material Data
Figure 1 – Interim Capping Options, Typical Cross Sections
Photos of Inundated Areas
Attachment A – Geotextile and Geomembrane Specifications
Attachment B – Topsoil and Reseeding Specification
Attachment C – Dredged Material Analytical

BRD/brd

Table 1 Summary of Dredged Material Data

Detected Constituents in Noyo Harbor Sediments					
Detected Analytes	**Units**	**Maximum**	**Mean**	**CHHSLs**	**PRGs**
Polycyclic Aromatic Hydrocarbons					
2-methylnaphthalene	mg/kg	0.036	--	NA	NA
Acenaphthene	mg/kg	0.017	--	NA	3,682
Fluorene	mg/kg	0.026	--	NA	2,747
Phenanthrene	mg/kg	0.036	--	NA	NA
Anthracene	mg/kg	0.016	--	NA	21,896
Fluoranthene	mg/kg	0.25	--	NA	2,294
Pyrene	mg/kg	0.21	--	NA	2,316
Benzo(a)anthracene	mg/kg	0.072	--	NA	0.62
Chrysene	mg/kg	0.097	--	NA	62
Benzo(b)fluoranthene	mg/kg	0.07	--	NA	0.62
Benzo(k)fluoranthene	mg/kg	0.066	--	NA	0.38
Benzo(a)pyrene	mg/kg	**0.054**	0.024	0.038	0.062
Indeno(1,2,3-cd)pyrene	mg/kg	0.027	--	NA	0.62
Benzo(g,h,i)perylene	mg/kg	0.021	--	NA	NA
Phthalates					
Dimethylphthalate	mg/kg	0.036	--	NA	100,000
Diethylphthalate	mg/kg	0.013	--	NA	48,882
Di-n-butylphthalate	mg/kg	0.04	--	NA	6,110
Bis(2-ethylhexyl)phthalate	mg/kg	0.79	--	NA	35
D-n-octylphthalate	mg/kg	0.037	--	NA	2,444
Metals					
Arsenic	mg/kg	**2.9**	**2.58**	0.07[a]	--
Barium	mg/kg	130	--	5200	--
Beryllium	mg/kg	0.71	--	150	--
Cadmium	mg/kg	0.15	--	2	--
Chromium	mg/kg	46	--	100,000[b]	--
Cobalt	mg/kg	11.0	--	660	--
Copper	mg/kg	34	--	3,000	--
Lead	mg/kg	9.1	--	150	--
Mercury	mg/kg	0.09	--	18	--
Molybdenum	mg/kg	0.31	--	380	--
Nickel	mg/kg	31	--	1,600	--
Silver	mg/kg	0.31	--	380	--
Thallium	mg/kg	0.28	--	5	--
Vanadium	mg/kg	52	--	530	--
Zinc	mg/kg	72	--	23,000	--

mg/kg = milligrams per kilogram
CHHSL = California Human Health Screening Level (OEHHA, 2005)
PRG = Preliminary Remediation Goal (USEPA, 2004)

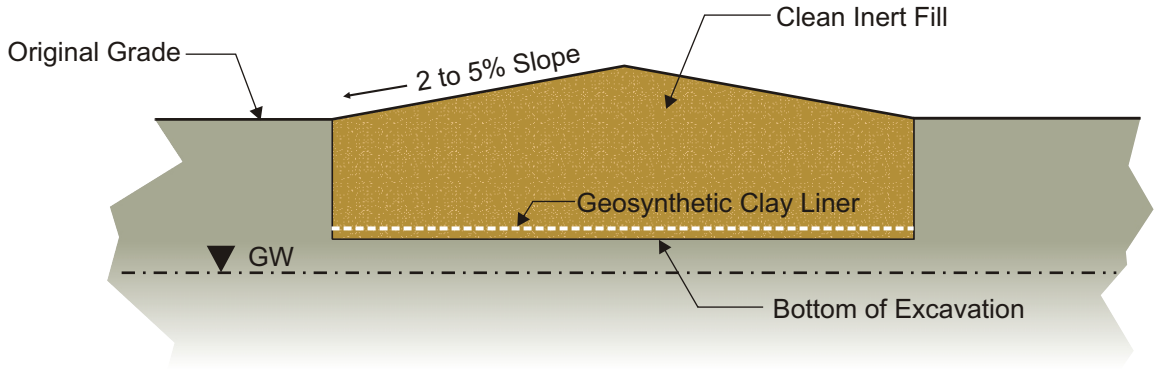
[a] Background levels for arsenic in California range from 0.6 to 11 mg/kg (Bradford et al., 1996)
[b] CHHSL for Chromium III

Notes:
All other analytes (other CAM metals, PAHs, PCBs, pesticides, and phthlates) were non-detect.

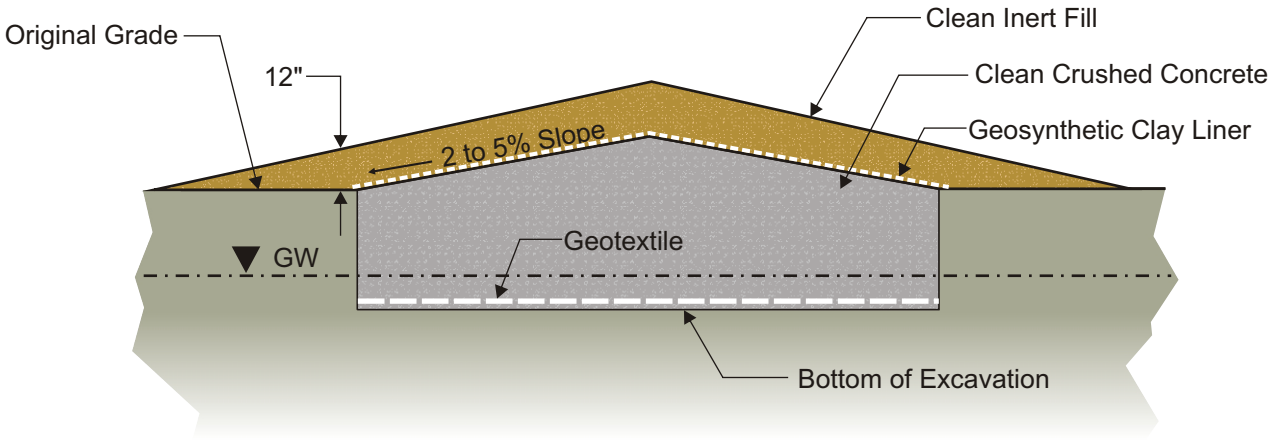
CHHSLs were listed preferentially. For those chemicals without CHHSLs, PRGs were used.

Only arsenic and benzo(a)pyrene were above screening levels. Arsenic is likely within background levels, as is benzo(a)pyrene; the mean concentration of benzo(a)pyrene was below screening levels. Because the samples were taken when the sediment was in place in the harbor, the mean concentration is more representative of the existing stockpile, although the samples were collected in 1998 and the concentrations have likely decreased (attenuated).

Dry Interim Cap



Wet Interim Cap



FORMER FORT BRAGG SAWMILL
FORT BRAGG, CALIFORNIA

FOUNDATION EXCAVATIONS

INTERIM CAPPING OPTIONS
TYPICAL CROSS SECTIONS

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FIGURE
1

Central Powerhouse Area

Central Powerhouse Area

Main Powerhouse Area

Sawmill Area Looking West

Attachment A

Geotextile and Geomembrane Specifications

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SECTION 02311 - GEOTEXTILE

1 GENERAL

1.1 SCOPE

Contractor shall furnish all geotextile, labor, incidental materials, tools, supervision, transportation, and installation equipment necessary for the installation of geotextile, as specified herein, and as shown on the drawings.

1.2 REFERENCES

ASTM D 5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles

ASTM D 4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

ASTM D 4533, Standard Test Method for Index Trapezoidal Tearing Strength of Geotextiles

ASTM D 4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products

ASTM D 4491, Standard Test Method for Water Permeability of Geotextiles by Permittivity

ASTM D 4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile

ASTM D 4354, Standard Practice for Sampling of Geosynthetics for Testing

ASTM D 4759, Standard Practice for Determining the Specifications Conformance of Geosynthetics

1.3 SUBMITTALS

A. Prior to material delivery to project site, the contractor shall provide the engineer with a written certification or manufacturers quality control data which displays that the geotextile meets or exceeds minimum average roll values (MARV) specified herein.

B. The contractor shall submit, if required by the engineer, manufacturer’s quality control manual for the geotextile to be delivered to the site.

2 PRODUCT

2.1 GEOTEXTILE

A. Geotextile material used on the project shall be NW8 (Table 1.1) or approved equivalent.

B. The non-woven needle punched geotextile specified herein shall be made from polypropylene staple fiber.

C. The geotextile shall be manufactured from prime quality virgin polymer.

D. The geotextile shall be able to withstand direct exposure to ultraviolet radiation from Sun for up to 30 days without any noticeable effect on index or performance properties.

E. Geotextile shall meet or exceed all material properties listed in Table 1.1.

Table 1.1 – Minimum Average Roll Values (MARV) Required for Nonwoven Needlepunched Geotextiles:

TESTED PROPERTY	TEST METHOD	FREQUENCY	NW4	NW6	NW8	NW10	NW12	NW16
Product Code			GEO 0408002	GEO 0608002	GEO 0808002	GEO 1008002	GEO 1208002	GEO 1608002
AASHTO M288 Class			3	2	1	>1	>>1	>>>1
Mass per Unit Area, oz/yd^2 (g/m^2)	ASTM D 5261	90,000 ft^2	4 (135)	6 (200)	8 (270)	10 (335)	12 (405)	16 (540)
Thickness	ASTM D 5199	1/90,000 ft^2	45 mil	70 mil	80 mil	100 mil	110 mil	155 mil
Grab Tensile Strength, lb (N)	ASTM D 4632	90,000 ft^2	120 (530)	170 (755)	220 (975)	260 (1,155)	320 (1,420)	390 (1,735)
Grab Elongation, %	ASTM D 4632	90,000 ft^2	50	50	50	50	50	50
Puncture Strength, lb (N)	ASTM D 4833	90,000 ft^2	60 (265)	90 (395)	120 (525)	165 (725)	190 (835)	240 (1,055)
Trapezoidal Tear Strength, lb (N)	ASTM D 4533	90,000 ft^2	50 (220)	70 (310)	95 (420)	100 (445)	125 (555)	150 (665)
Apparent Opening Size, Sieve No. (mm)	ASTM D 4751	540,000 ft^2	70 (0.212)	70 (0.212)	80 (0.180)	100 (0.150)	100 (0.150)	100 (0.150)
Permittivity, sec^{-1}	ASTM D 4491	540,000 ft^2	1.50	1.50	1.50	1.20	0.80	0.70
Permeability, cm/sec	ASTM D 4491	540,000 ft^2	0.22	0.30	0.30	0.30	0.29	0.27
Water Flow Rate, gpm/ft^2 (l/min/m^2)	ASTM D 4491	540,000 ft^2	120 (4,885)	110 (4,480)	110 (4,480)	85 (3,460)	60 (2,440)	50 (2,035)
UV Resistance (% retained after 500 hours)	ASTM D 4355	per formulation	70	70	70	70	70	70
Roll Length[1], ft (m)			600 (182)	600 (182)	600 (182)	300 (91)	300 (91)	300 (91)
Roll Width[1], ft (m)			15 (4.6)	15 (4.6)	15 (4.6)	15 (4.6)	15 (4.6)	15 (4.6)
Roll Area, ft^2 (m^2)			9,000 (836)	9,000 (836)	9,000 (836)	4,500 (418)	4,500 (418)	4,500 (418)

NOTES:

- The property values listed are in weaker principal direction. All values listed are Minimum Average Roll Values (MARV) except apparent opening size in mm and UV resistance. Apparent opening size (mm) is a Maximum Average Roll Value. UV is a typical value.
- [1]Roll lengths and widths have a tolerance of ±1%.

2.2 MANUFACTURE

All rolls of the geotextile shall be identified with permanent marking on the roll or packaging, with the manufacturers name, product identification, roll number and roll dimensions.

2.3 TRANSPORT

A. Transportation of the geotextile shall be the responsibility of the contractor.

B. During shipment, the geotextile shall be protected from ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, or other damaging or deleterious conditions.

C. Upon delivery at the job site, the contractor shall ensure that the geotextile rolls are handled and stored in accordance with the manufacturer's instructions as to prevent damage.

3. EXECUTION

3.1 QUALITY ASSURANCE

A. The engineer shall examine the geotextile rolls upon delivery to the site and report any deviations from project specifications to the contractor.

B. The engineer may decide to arrange conformance testing of the rolls delivered to the job site. For this purpose, the engineer shall take a sample three feet (along roll length) by roll width according to ASTM Practice D 4354 The sample shall be properly marked, wrapped and sent to an independent laboratory for conformance testing.

C. The pass or fail of the conformance test results shall be determined according to ASTM Practice D 4759.

3.2 INSTALLATION

A. The geotextile shall be handled in such a manner as to ensure that it is not damaged in any way. Should the contractor damage the geotextile to the extent that it is no longer usable as determined by these specifications or by the engineer, the contractor shall replace the geotextile at his own cost.

B. The geotextile shall be installed to the lines and grades as shown on the contract drawings and as described herein.

C. The geotextile shall be rolled down the slope in such a manner as to continuously keep the geotextile in tension by self weight. The geotextile shall be securely anchored in an anchor trench where applicable, or by other approved or specified methods.

D. In the presence of wind, all geotextiles shall be weighted by sandbags or approved equivalent. Such anchors shall be installed during placement and shall remain in place until replaced with cover material.

E. The contractor shall take necessary precautions to prevent damage to adjacent or underlying materials during placement of the geotextile. Should damage to such material occur due to the fault of the contractor, the latter shall repair the damaged materials at his own cost and to the satisfaction of the engineer.

F. During placement of the geotextile, care shall be taken not to entrap soil, stones or excessive moisture that could hamper subsequent seaming of the geotextile as judged by the engineer.

G. The geotextile shall not be exposed to precipitation prior to being installed and shall not be exposed to direct Sun light for more than 15 days after installation.

H. The geotextile shall be seamed using heat seaming or stitching methods as recommended by the manufacturer and approved by the engineer. Sewn seams shall be made using polymeric thread with chemical resistance equal to or exceeding that of the geotextile. All sewn seams shall be continuous. Seams shall be oriented down slopes perpendicular to grading contours unless otherwise specified. For heat seaming, fusion welding techniques recommended by the manufacturer shall be used.

I. The contractor shall not use heavy equipment to traffic above the geotextile without approved protection.

J. The geotextile shall be covered as soon as possible after installation and approval. Installed geotextile shall not be left exposed for more than 15 days.

K. Material overlying the geotextile shall be carefully placed to avoid wrinkling or damage to the geotextile.

END OF SECTION

SECTION 02312 – GEOSYNTHETIC CLAY LINER

GENERAL Scope - This specification details the technical requirements for the supply and installation of a needlepunched Geosynthetic Clay Liner (GCL). The material(s) furnished and installation performed shall be in strict accordance with these requirements and the contract drawings.

1.1. Definitions - For the purposes of this specification the following definitions shall apply:

1.1.1. Geosynthetic Clay Liner (GCL) - A factory manufactured hydraulic barrier consisting of granular sodium bentonite clay, sandwiched between, supported and encapsulated by two geotextiles, held together by needlepunching.

1.1.2. Geotextile - A semi-permeable woven or nonwoven fabric used to contain the bentonite used in a GCL.

1.1.3. Sodium Bentonite - The high swelling clay component of GCLs consisting primarily of the mineral Montmorillonite.

1.1.4. Needlepunching - A GCL manufacturing process whereby boards of barbed needles incorporate the staple fibers from a nonwoven geotextile, through a sodium bentonite clay layer, into the matrix of a second geotextile layer.

1.1.5. Thermal Locking - A needlepunching enhancement process utilizing heat to bond the needlepunched fibers and more permanently lock them into the second geotextile to increase the internal shear strength characteristics.

1.1.6. Minimum Average Roll Value (MARV) - The minimum average value of the material in a particular lot calculated as the mean of the tested values minus two standard deviations providing a 95% confidence level.

1.2. References - The following test methods shall be incorporated into this specification in their entirety, subject to the indicated test modifications:

- ASTM D 4632, "Standard Test Method for Grab Breaking Load and Elongation of Geotextiles"
- ASTM D 4643, “Determination of Water (Moisture) Content of Soil by the Microwave Oven Method”
- ASTM D 5084, “Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter”
- ASTM D 5261, “Standard Test Method for Measuring Mass Per Unit Area of Geotextiles”
- ASTM D 5321, “Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method”
- ASTM D 5887, "Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter"
- ASTM D 5888, “Standard Guide for Storage and Handling of Geosynthetic Clay Liners”
- ASTM D 5889, “Standard Practice for Quality Control of Geosynthetic Clay Liners”
- ASTM D 5890, “Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners”

- ASTM D 5891, “Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners”
- ASTM D 5993, "Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners"
- ASTM D 6102, "Standard Guide for Installation of Geosynthetic Clay Liners"
- ASTM D 6243, "Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method"
- ASTM D 6496, "Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners"
- ASTM D 6768, "Standard Test Method for Tensile Strength of Geosynthetic Clay Liners"
- ASTM E 96, "Standard Test Methods for Water Vapor Transmission of Materials"

2.0 QUALIFICATIONS - The GCL Manufacturer, Installer and Construction Quality Assurance (CQA) inspector shall all be skilled in accordance with the following experience requirements. Any exceptions must be approved by the project engineer prior to the project bid.

2.1. GCL Manufacturer - The GCL manufacturer selected for use on this project shall have successfully produced at least 10,000,000 square feet of needlepunched GCL product.

2.2. GCL Installer - The installer shall provide to the engineer sufficient evidence of installation experience and competence with the specified geosynthetic materials.

2.2.1. GCL Only Installation - The GCL installer shall demonstrate a minimum of 1,000,000 square feet of GCL installation experience, shall provide sufficient evidence of installation experience and competence with other geosynthetics or shall demonstrate an acceptable level of training and supervision will be utilized in order to ensure the quality of the installation.

2.2.2. Multi-Component Composite Liner System - The GCL shall be installed by the lining contractor responsible for the installation of the overlying FML. The GCL/FML lining contractor shall demonstrate a minimum of 1,000,000 square feet of successfully completed multi-component composite liner installation experience or shall provide sufficient evidence of the appropriate level of installation experience and competence with other geosynthetics.

2.3. Construction Quality Assurance (CQA) Inspector - The third party project inspector shall be designated a minimum of 15 business days prior to construction in order to facilitate the possibility of in plant material pre-qualification.

The specific CQA inspector designated by the CQA contractor shall be responsible for all aspects of the QA program, including the documentation and monitoring of the manufacturing and installation processes. The CQA inspector shall be an independent, third party consultant with a minimum of 1,000,000 square feet of GCL inspection experience, on a minimum of 5 projects.

2.4. Submittals - Three copies of the project submittals shall be forwarded to the project engineer as designated below:

2.4.1. Unit Prices Bid - The square footage and associated pricing shall be based on "measured in place" quantities or quantity delivered to the project site as determined by the project engineer.

2.4.1.1. Measured In Place - Measured in place quantities shall be determined from the project drawings, including any allowances for waste, overlap, and anchoring. Final quantities will be payable based on the as-built drawings.

2.4.1.2. Delivered to Site - Delivered pricing quantities shall be determined from the manufacturer's shipping documents and reflect the total square footage delivered to the project site.

2.4.2. Information With Bid - The following shall be submitted with the bid:

2.4.2.1. Statement of experience from the proposed GCL supplier.

2.4.2.2. Statement of experience from the proposed GCL Installer.

2.4.3. Prior to Installation - The following information shall be supplied to the project engineer for review within 10 business days of the Contract Award to ensure that the materials and parties selected for use on the project meet the requirements of this specification:

2.4.3.1. Samples of GCL proposed for use on the project.

2.4.3.2. Reference list supplied by GCL Manufacturer indicating the appropriate experience level as required by the specification.

2.4.3.3. Reference list supplied by the GCL Installer indicating the appropriate experience level as required by the specification.

2.4.3.4. Reference list supplied by the proposed CQA Inspector indicating the appropriate experience level as required by the specification.

2.4.4. Prior to Deployment - The following information shall be submitted by the Lining Contractor to the Project Engineer prior to the deployment of any GCL material to ensure that the materials and subgrade preparation meet the requirements of this specification:

2.4.4.1. GCL Manufacturer's Quality Control Certifications.

2.4.4.2. Certifications of subgrade acceptance for each area covered by GCL, signed by the earthwork Contractor and CQA inspector.

3.0 GCL MATERIALS - The GCL product supplied to the project shall be in full accordance with the requirements of this section. The GCL shall be manufactured by mechanically bonding the geotextiles using a needlepunching process to enhance frictional and internal shear strength characteristics.

In order to maintain these characteristics, no glues, adhesives or other non-mechanical bonding processes shall be used in lieu of the needlepunch process. Their use to enhance the physical properties of the GCL is permitted.

3.1. Description - Acceptable GCLs for this project include the Bentofix EC , or any other needlepunched GCLs which meet the requirements of this specification.

3.2. GCL Manufacturing - The GCL supplied in accordance with this project shall be manufactured by needlepunching as described in Section 1.2 - Definitions.

3.2.1. The needlepunched GCL shall be thermally locked. The thermal lock process must heat set the nonwoven fibers where they protrude from the second geotextile (woven or nonwoven depending upon product) to more permanently secure the reinforcement in place. Other means may be used to lock the fibers in place if the process demonstrates similar performance to the thermal lock process.

3.2.2. To demonstrate the uniformity of the manufacturing process, no delamination of the geotextile components from the bentonite core shall occur when the GCL is exposed to 80 degree tap water for one hour.

3.3. Alternative Materials - Prior to considering an alternative GCL material, the Contractor shall submit certified test results and statements of quality from the proposed GCL supplier to the engineer, indicating without exception that the proposed GCL meets the requirements of this specification. Submittals shall be delivered to the engineer a minimum of five business days in advance of the bid.

No other manufacturing techniques shall be approved unless it can be suitably demonstrated that the GCL exhibits uniform shear strength characteristics across the entire width of the panel. Isolated sewn or stitched rows do not constitute uniform reinforcement for the purposes of this specification.

3.4. GCL Physical Properties - The GCL material shall be in accordance with the test methods, test frequencies and material physical properties as listed in the Appendix.

3.4.1. Standard Conditions - For projects where a standard woven - bentonite - nonwoven GCL will provide sufficient interface shear properties, the GCL supplied for this project shall be in accordance with the test methods, test frequencies and material physical properties as listed in the attached Product Data Sheet Bentofix EC GCL.

3.5. Dimensions - The minimum acceptable dimensions for the GCL panels shall be 15 feet wide and 125 feet long. Short rolls (rolls less than 125 feet long) may be supplied, but at a rate not to exceed 5% of the total square footage produced for this project.

3.6. Overlap Markings - A minimum overlap guide-line and a construction match-line delineating the overlap zone shall be imprinted with non-toxic ink on both edges of the GCL panel to ensure the accuracy of the seam. These lines shall be used during CQA to ensure the minimum overlap is achieved. The minimum overlap guideline shall indicate where the edge of the panel must be placed in order to achieve a full six inches of bentonite overlap for each panel.

3.7. Manufacturing Quality Control - The GCL shall be tested for compliance with this specification by the test methods and frequencies indicated on the material specification in Appendix A or B as appropriate. GCL materials may be tested pre-approved at the manufacturing location.

3.7.1. Manufacturer Quality Control Certification - Quality Control certificates shall be issued by the GCL manufacturer to the project engineer, CQA inspector or other designated party for each delivery of material. The certifications shall be signed by the quality control manager of the GCL manufacturer or other responsible party and shall include the following information:

- Shipment Packing List - A list indicating the rolls shipped on a particular truckload.
- Bill of Lading - The shipping documents for the truck used for the shipment.
- Letter of Certification - The letter indicating the material is in conformance with the physical properties specified.
- Physical Properties Sheet - The material specification for the GCL supplied in accordance with this specification.

3.7.2. Manufacturer Quality Control Submittal - Quality Control submittals shall be issued by the GCL manufacturer to the project engineer, CQA inspector or other designated party for each lot of material if necessary. The submittals shall include the following information:

3.7.2.1. Bentonite Manufacturer Certification - Bentonite manufacturer quality documentation for the particular lot of clay used in the production of the rolls delivered.

3.7.2.2. Geotextile Manufacturer Certification - Geotextile manufacturer quality control documentation for the particular lots of geotextiles used in the production of the rolls delivered.

3.7.2.3. GCL Manufacturer Tracking List - Cross referencing list delineating the corresponding geotextile and bentonite lots for the materials used in the production of the rolls delivered.

3.7.2.4. Manufacturing Quality Control Data - The manufacturing quality control test data indicating the actual test values obtained when tested at the appropriate frequencies for the properties specified in Appendix A or B.

3.8. Packaging - All GCL rolls shall be packaged in moisture resistant plastic sleeves. The cardboard cores shall be sufficiently strong to resist collapse during transit and handling.

3.9. Roll Identification and Labeling - Prior to shipment, the manufacturer shall label each roll, both on the GCL roll and on the surface of the plastic protective sleeve. Labels shall be resistant to fading and moisture degradation to ensure legibility at the time of the installation. At a minimum the roll labels shall identify the following:

- Length and width of roll
- Total weight of roll
- Type of GCL material
- Production Lot number and Individual Roll number

3.10. Accessory Bentonite - Any accessory bentonite used for sealing seams, penetrations, or repairs, shall be the same granular bentonite as used in the production of the GCL itself.

4.0 EXECUTION - The following installation procedures are as specific as possible while recognizing that the specific requirements of the project may necessitate minor modifications. Significant deviations from these procedures shall be pre-approved by the project engineer or other designated party.

4.1. Shipping and Handling Equipment - The party responsible for unloading the GCL shall contact the manufacturer prior to shipment to determine the correct unloading methods and equipment if different from the pre-approved and specified methods.

Bentofix Geosynthetic Clay Liner (GCL) must be supported during handling to ensure worker safety and prevent damage to the liner. Under approved circumstances only, shall the rolls be dragged, lifted from one end, lifted with only the forks of a lift truck or pushed to the ground from the delivery vehicle.

The QCA inspector shall verify that proper handling equipment exists which does not pose any danger to installation personnel or risk of damage or deformation to the liner material itself. Suitable handling equipment is described below:

4.1.1. Spreader Bar Assembly - A spreader bar assembly shall include both a core pipe or bar and a spreader bar beam. The core pipe shall be used to uniformly support the roll when inserted through the GCL core while the spreader bar beam will prevent chains or straps from chafing the roll edges.

4.1.2. Stinger - A stinger is a rigid pipe or rod with one end directly connected to a forklift or other handling equipment. If a stinger is used, it should be fully inserted to it's full length into the roll to prevent excessive bending of the roll when lifted.

4.1.3. Roller Cradles - Roller cradles consist of two large diameter rollers spaced approximately 3 inches apart, which both support the GCL roll and allow it to freely unroll. The use of roller cradles shall be permitted if the rollers support the entire width of the GCL roll.

4.1.4. Straps - Straps may be used to support the ends of spreader bars but are not recommended as the primary support mechanism. As straps may damage the GCL where wrapped around the roll and generally do not provide sufficient uniform support to prevent roll bending or deformation, great care must be exercised when this option is used.

4.2. GCL Inspection Upon Delivery - Each roll shall be visually inspected when unloaded to determine if any packaging or material has been damaged during transit. Repairs to damaged GCL shall be performed in accordance with Section 4.6.5 of this specification.

4.2.1. Rolls exhibiting damage shall be marked and set aside for closer examination during deployment.

4.2.2. Minor rips or tears in the plastic packaging shall be repaired with moisture resistant tape prior to being placed in storage to prevent moisture damage.

4.2.3. GCL rolls delivered to the project site shall be only those indicated on GCL manufacturing quality control certificates.

4.3. Storage / Stockpiling / Staging - Storage of the GCL rolls shall be the responsibility of the installer or other designated party. All GCL rolls shall be stock-piled and maintained dry in a flat location area away from high-traffic areas but sufficiently close to the active work area to minimize handling.

For needlepunched GCLs, the presence of free-flowing water within the packaging shall require that roll to be set aside for further examination to ascertain the extent of damage, if any. Free-flowing water within the packaging of unreinforced GCLs shall be cause for rejection of that roll.

4.3.1. GCL should be stored no higher than three to four rolls high or limited to the height at which the handling apparatus may be safely handled by installation personnel. Stacks or tiers of rolls should be situated in a manner that prevents sliding or rolling by "choking" the bottom layer of rolls.

4.3.2. Rolls shall not be stacked on uneven or discontinuous surfaces in order to prevent bending, deformation, damage to the GCL or cause difficulty inserting the core pipe.

4.3.3. An additional tarpaulin or plastic sheet shall be used over the stacked rolls to provide extra protection for GCL material stored outdoors.

4.3.4. Bagged bentonite material shall be stored and tarped next to GCL rolls unless other more protective measures are available. Bags shall be stored on pallets or other suitably dry surface which will prevent undue prehydration.

4.4. Manufacturing Quality Assurance Documentation - Third party GCL MQA sampling and testing for compliance with this specification shall be coordinated by the third party CQA inspector as necessary to support the manufacturer's MQC data.

4.5. Subgrade Preparation - The surfaces upon which the GCL shall be suitable for the placement of GCL material, subject to the applicable section of this specification (Earthen - 4.5.1 or Geosynthetic - 4.5.2).

4.5.1. Earthen Subgrade - The surface upon which the GCL material will be installed shall be inspected by the CQA inspector and certified by the earthwork contractor to be in accordance with the requirements of this specification.

4.5.1.1. The subgrade soil shall be well graded containing no gravel greater than 2 inches and no sharp stones larger than 0.75 inches.

4.5.1.2. In applications where the GCL is the sole barrier and will be subjected to a hydraulic head that exceeds the confining stress, subgrade surfaces consisting of gravel or granular soils may not be appropriate due to their large void content. For these applications, the subgrade will contain no sharp stones greater than 0.75 in.

4.5.1.3. Site specific compaction requirements should be followed in accordance with the project drawings and specifications. At a minimum, the level of compaction should be such that no rutting is

caused by installation equipment or other construction vehicles which traffic the area of deployment (typically 85% of standard proctor or greater).

4.5.1.4. The surfaces to be lined shall be smooth and free of any debris, vegetation, roots, sticks, sharp rocks, or other deleterious materials larger than two inches as well as free of any voids, large cracks or standing water or ice.

4.5.1.5. Directly prior to deployment of the GCL, the subgrade shall be final-graded to fill remaining voids or desiccation cracks to eliminate sharp irregularities or abrupt elevation changes. The surfaces to be lined shall be maintained in this smooth condition.

4.5.2. Geosynthetic Subgrade - Prior to GCL deployment the geosynthetic surface as well as other underlying geosynthetics upon which the GCL material will be installed shall be inspected and approved by the third party CQA inspector in accordance with the requirements of the project specification documents.

4.5.3. Anchor Trench - An anchor trench shall be excavated by the earthwork contractor or liner installer to the lines and grades shown on the project drawings at the top of slopes.

4.5.3.1. The anchor trench shall be constructed free of sharp edges or corners and maintained in a dry condition. No loose soil shall be permitted beneath the GCL within the trench.

4.5.3.2. The anchor trench shall be inspected and approved by the CQA inspector prior to GCL placement, back-filling and compaction of the anchor key material.

4.5.4. Subgrade Inspection - The earthen or geosynthetic subgrade shall be continuously inspected, approved and certified by the CQA inspector prior to GCL placement.

Subsequent to the CQA inspector's approval, it shall be the installer's responsibility to indicate to the Engineer any change in the subgrade condition that could cause it to be out of compliance with any of the requirements of this section or the project specification.

4.6. GCL Placement - GCL Material shall be placed in general accordance with the procedures specified below, or modified to account for site specific conditions.

4.6.1. GCL Orientation - GCL panels should be placed with the nonwoven side up (heat burnished side down) to maximize the shear strength characteristics. In base or flat areas, the GCL does not require any particular orientation.

4.6.2. GCL Panel Position - Where possible, all slope panels should be installed parallel to the maximum slope while panels installed in flat areas require no particular orientation.

4.6.3. Panel Deployment - GCL materials shall be installed in general accordance with the procedures set forth in this section, subject to site specific conditions which would necessitate modifications.

Reinforced GCL shall be used on both slopes as well as the flat areas to ensure the GCL withstands the rigors of the installation and subsequent low load hydration.

4.6.3.1. Deployment should proceed from the highest elevation to the lowest to facilitate drainage in the event of precipitation.

4.6.3.2. The GCL may be deployed on slopes by pulling the material from a suspended roll, or securing a roll end into an anchor trench and unrolling each panel as the handling equipment slowly moves backwards.

4.6.3.3. Deployment on flat areas shall be conducted in the same manner as that for the slopes, however, care should be taken to minimize "dragging" the GCL. Slip-sheet may be used to facilitate positioning of the liner while ensuring the GCL is not damaged from underlying sources.

4.6.3.4. Overlaps shall be a minimum of 6 inches and be free of wrinkles, folds or "fish-mouths".

4.6.3.5. The contractor shall only install as much GCL that can be covered at the end of the day. No GCL shall be left exposed overnight. The exposed edge of the GCL shall be covered by a temporary tarpaulin or other such water resistant sheeting until the next working day.

4.6.4. Anchoring- All GCL material installed on slopes shall be anchored to prevent potential GCL panel movement.

4.6.4.1. Standard Anchor - The GCL shall be placed into and across the base of the excavated trench, stopping at the back wall of the excavation.

4.6.4.2. "Run-Out" Anchor - On gentle slopes or locations where it is difficult to create an anchor trench, the GCL may alternatively be anchored by a material run-out past the crest of the slope. The length of the run-out shall be pre-approved by the project engineer prior to the use of this method.

4.6.5. Seaming - A 6-inch lap line and a 9-inch match line shall be imprinted on both edges of the upper geotextile component of the GCL to assist in installation overlap quality control. Lines shall be printed as continuous dashes in easily observable non-toxic ink.

4.6.5.1. Overlap seams shall be a minimum of six inches on panel edges and one foot on panel ends.

4.6.5.2. Loose granular bentonite should be placed between panel overlaps at a rate of 0.25 pound per lineal foot.

4.6.6. Detailing - Detail work, defined as the sealing of the liner to pipe penetrations, foundation walls, drainage structures, spillways, and other appurtenances, shall be performed as recommended by the GCL Manufacturer.

4.6.7. Damage Repair - Prior to cover material placement, damage to the GCL shall be identified and repaired by the installer. Damage is defined as any rips or tears in the geotextiles, delamination of geotextiles or a displaced panel.

4.6.7.1. Rip and Tear Repair (Flat Surfaces) - Rips or tears may be repaired by completely exposing the affected area, removing all foreign objects or soil, and by then placing a patch cut from unused GCL over the

damage (damaged material may be left in place), with a minimum overlap of 12 inches on all edges. Accessory bentonite should be placed between the patch edges and the repaired material at a rate of a quarter pound per lineal foot of edge spread in a continuous six inch fillet.

4.6.7.2. Rip and Tear Repair (Slopes) - Damaged GCL material on slopes shall be repaired by the same procedures above, however, the edges of the patch should also be adhered to the repaired liner with an adhesive to keep the patch in position during backfill or cover operations.

4.6.7.3. Displaced Panels - Displaced panels shall be adjusted to the correct position and orientation. The adjusted panel shall then be inspected for any geotextile damage or bentonite loss. Damage shall be repaired by the above procedure.

4.6.7.4. Premature Hydration - If the GCL is prematurely hydrated greater than 30% moisture, installer shall notify the QA/QC technician and project engineer for a site specific determination as to whether the material is acceptable or if alternative measures must be taken to ensure the quality of the design.

4.7. Cover Material - The cover materials shall be compatible as well as suitable for use over the GCL, and placed in a manner appropriate to the particular subgrade. Regardless of the cover material, the uncovered edge of GCL panels shall be protected at the end of the working day with a waterproof sheet which is secured adequately with ballast.

4.7.1. Earthen Cover Soil - If the cover material is soil or gravel, a minimum thickness of 12 inches shall be placed over the GCL. The soil cover shall be free of sharp-edged stones greater than 0.75 inches in size.

4.7.1.1. Equipment - Soil cover shall be placed with low ground pressure equipment. Care should be taken to avoid damaging the GCL by making sharp turns or pivots with equipment as well as sudden starts or stops.

4.7.1.2. Placement - Soils may be placed on the GCL by pushing with a track dozer or by carefully placing it with a loader or a back-hoe. The use of scrapers or pans directly over the GCL is strictly prohibited.

4.7.1.3. Thickness - A minimum thickness of 12 inches of cover shall be kept between heavy equipment and the GCL at all times. No heavy vehicles should be driven directly on the GCL until the proper thickness of cover has been placed.

4.7.1.4. Compaction - To prevent damage to the GCL, the initial lift(s) of soil cover shall not be compacted in excess of 85 percent Modified Proctor density or as specified by the engineer.

4.7.1.5. Slope Placement - When covering GCL on sloped areas, cover soil should be pushed up-slope to minimize tension on the GCL.

4.7.2. Geosynthetic Cover - Precautions shall be taken to prevent damage to the GCL by restricting the use of heavy equipment over the liner system.

4.7.2.1. Equipment - Installation of the overlying geosynthetic component can be accomplished through the use of lightweight, rubber-tired

equipment such as a 4-wheel all-terrain vehicle (ATV). This vehicle can be driven directly on the GCL, provided the ATV makes no sudden stops, starts, or turns.

4.7.2.2. Placement - Smooth HDPE may be dragged across the GCL surface with equipment or by hand labor during positioning. Similarly, the HDPE may be unrolled with the use of low ground pressure equipment.

4.7.2.3. Use of Textured Liners - If a textured geomembrane is placed over the GCL, a slip sheet (such as 20-mil smooth HDPE) may first be placed over the GCL in order to allow the geomembrane to slide into its proper position. Once the overlying geomembrane is properly positioned, the slip-sheet shall be carefully removed paying close attention to avoiding any movement to the geomembrane.

5.0 ACTIVATION - If the GCL will be utilized for the control of non-aqueous phase liquids, prehydration may be necessary. The GCL manufacturer shall be contacted for these cases for site specific recommendations.

6.0 WARRANTY - GCL material as well as installation warranties provided by the manufacturer and installer shall be made a part of the final submittal documents.

END OF SECTION

GSE®

GSE STANDARD PRODUCTS

Product Data Sheet

Bentofix® EC GCL

Bentofix® **"EC"** geosynthetic clay liner (GCL) is a lightly needlepunched reinforced composite comprised of a uniform layer of granular sodium bentonite encapsulated between a woven and a nonwoven geotextile. It is intended for use on relatively flat slope surfaces where minimal internal shear strength is required.

Product Specifications

GEOTEXTILE PROPERTIES	TEST METHOD	FREQUENCY	VALUE (ENGLISH)	VALUE (SI)
Product Code			BFIX1000EC	
Cap Nonwoven, Mass/Unit Area	ASTM D 5261	1/200,000 ft² (1/20,000 m²)	3.0 oz/yd² Typical	100 g/m² Typical
Carrier Scrim Woven, Mass/Unit Area	ASTM D 5261	1/200,000 ft² (1/20,000 m²)	3.1 oz/yd² Typical	105 g/m² Typical
BENTONITE PROPERTIES				
Swell Index	ASTM D 5890	1/100,000 lb (50,000 kg)	24 ml/2 g min	24 ml/2 g min
Moisture Content	ASTM D 4643	1/100,000 lb (50,000 kg)	12% max	12% max
Fluid Loss	ASTM D 5891	1/100,000 lb (50,000 kg)	18 ml max	18 ml max
FINISHED GCL PROPERTIES				
Bentonite, Mass/Unit Area[1]	ASTM D 5993	1/40,000 ft² (1/4,000 m²)	0.75 lb/ft² MARV	3.66 kg/m² MARV
Tensile Properties,				
Tensile Strength[4]	ASTM D 6768	1/40,000 ft² (1/4,000 m²)	30 lb/in MARV	5 kN/m MARV
Grab Strength[2]	ASTM D 4632		80 lb Typical	354 N Typical
Grab Elongation[2]	ASTM D 4632		100% Typical	100% Typical
Peel Strength[3]	ASTM D 6496	1/40,000 ft² (1/4,000 m²)	0.8 lb/in Typical	140 N/m Typical
	ASTM D 4632		5 lb Typical	22 N Typical
Hydraulic Conductivity[4]	ASTM D 5887	1/Week	5×10^{-11} m/sec max	5×10^{-11} m/sec max
Index Flux[4]	ASTM D 5887	1/Week	1×10^{-8} m³/m²/sec max	1×10^{-8} m³/m²/sec max
Internal Shear Strength[5]	ASTM D 6243	Periodically	100 psf Typical	4.8 kPa Typical
ROLL DIMENSIONS				
Width x Length[6]	Typical	Every Roll	15.5 ft x 150 ft	4.7 m x 45.7 m
Area per Roll	Typical	Every Roll	2,325 ft²	216 m²
Packaged Weight	Typical	Every Roll	2,600 lb	1,179 kg

NOTES:

- [1]Oven-dried measurement. Equates to 0.84 lb/ft² (4.1 kg/m²) when indexed to a 12% moisture content.
- [2]Measured at maximum peak, in weakest principal direction. Elongation is provided for reference only.
- [3]Modified to use a 4 in (100 mm) wide grip. The maximum peak of five specimens averaged.
- [4]4 in (100 mm) wide sample, average of 5 specimens.
- [5]Typical peak value for specimen hydrated for 24 hours and sheared under a 200 psf (9.6 kPa) normal stress.
- [6]Roll widths and lengths have a tolerance of ±1%.

DS044ec R03/07/06

North America	GSE Lining Technology, Inc.	Houston, Texas	800 435 2008	281 443 8564	Fax: 281 230 8650
South America	GSE Lining Technology Chile S.A.	Santiago, Chile		56 2 595 4200	Fax: 56 2 595 4290
Asia Pacific	GSE Lining Technology Company Limited	Bangkok, Thailand		66 2 937 0091	Fax: 66 2 937 0097
Europe & Africa	GSE Lining Technology GmbH	Hamburg, Germany		49 40 767420	Fax: 49 40 7674234
Middle East	GSE Lining Technology-Egypt	The 6th of October City, Egypt		202 2 828 8888	Fax: 202 2 828 8889

www.gseworld.com

Attachment B

Topsoil and Reseeding Specification

BBL®
an ARCADIS company

MATERIALS AND PERFORMANCE - SECTION 02210

TOPSOIL & SEEDING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Specified

1. The furnishing and placement of topsoil, fertilizer, seed, and/or mulch.

2. The maintenance required until acceptance.

PART 2 - PRODUCTS

2.01 MATERIALS

A. If topsoil is needed (i.e., if backfill is not suitable to support native plants), imported topsoil shall be used that consists of unfrozen friable clayey loam free from clay lumps, stones, roots, sticks, stumps, brush, and foreign objects. The topsoil shall have a pH ranging between 5.0 and 7.5 and an organic content between 5 and 20 percent, as determined by laboratory testing of representative samples.

B. Fertilizer shall be standard quality commercial carrier of available plant food elements. A complete, prepared, and packaged material containing a minimum of 6 percent nitrogen, 20 percent phosphoric acid, and 20 percent potash shall be required.

1. Each bag of fertilizer shall bear the manufacturer's guaranteed statement of analysis.

C. Seed mixtures shall be commercial stock of the current season's crop and shall be delivered in unopened containers bearing the guaranteed analysis of the mix.

1. All seed shall meet the State standards of germination and purity.
2. Seed can be purchased from:

LeBallisters seed & fertilizers	Pacific Coast Seed
1250 Sebastopol Rd.	533 Hawthorne Place
Santa Rosa, Ca 9507	Livermore, CA 94551
(707) 526-6733	(925) 373-4417

3. Approximately four acres shall be seeded at rate of 35 lbs./acre, totaling 140lbs of grass mix.
4. Estimated seed costs are as follows: $13.75/lb. x 140 lbs. = $1,925.00
5. The required erosion control species and pounds per acre are presented below.

MATERIALS AND PERFORMANCE - SECTION 02210

TOPSOIL & SEEDING

Common Name	Scientific Name	Rate of app. lbs./ per acre	Totals
Tufted Hairgrass	*Deschampsia caespitosa*	1.75	7 lbs.
Molate Fescue	*Festuca rubra*	17.5	70 lbs.
Meadow Barley(salt)	*Hordeum brachyantherum*	10.5	42 lbs.
Three Weeks Fescue	*Vulpia microstachys*	5.25	21 lbs.
	Totals	35 lbs.	140 lbs

6. Mulch shall be stalks of oats, wheat, rye, or other approved crops free from noxious weeds.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The area to receive topsoil (if deemed necessary) shall be graded to a depth of not less than 6 inches, or as specified, below the proposed finished surface. If the depth of topsoil existing prior to construction was greater than 6 inches, the topsoil shall be replaced not less than the greater depth.

a. All debris and inorganic material shall be removed and the surface loosened for a depth of 2 inches prior to the placing of the topsoil.

b. The topsoil shall not be placed until the subgrade is in suitable condition and shall be free of excessive moisture and frost.

c. All topsoil shall be free from stones, sticks, and other foreign substances and shall not be placed in a frozen or muddy condition.

d. Seeding and mulching shall not be done during high winds (greater than 15 miles per hour).

B. The fertilizer shall be applied uniformly. After the topsoil surface has been fine graded, the seed mixture shall be uniformly applied.

C. The mulch shall be hand or machine spread to form a continuous blanket over the seed bed. Excessive amounts or bunching of mulch will not be permitted.

1. Mulch shall be anchored by an acceptable method.

2. Unless otherwise specified, mulch shall be left in place and allowed to disintegrate.

3. Any anchorage or mulch that has not disintegrated at time of first mowing shall be removed. Anchors may be removed or driven flush with ground surface.

MATERIALS AND PERFORMANCE - SECTION 02210

TOPSOIL & SEEDING

D. Seeded areas shall be watered as often as required to obtain germination and to obtain and maintain a satisfactory sod growth. Watering shall be in such a manner as to prevent washing out of seed.

E. Hydroseeding may be accepted as an alternative method of applying fertilizer, seed, and mulch.

3.02 MAINTENANCE

A. All erosion rills or gullies within the topsoil layer shall be filled with additional topsoil and graded smooth, and reseeded and mulched.

B. The Contractor shall be responsible for repairs to all erosion of the seeded areas until all new grass is firmly established and reaches a height of not less than 4 inches. All bare and poorly vegetated areas must be reseeded and mulched.

- END OF SECTION -

Attachment C

Dredged Material Analytical

BBL®
an ARCADIS company

CHEMICAL ANALYSIS OF SEDIMENTS FROM

NOYO HARBOR

FY1998 MAINTENANCE DREDGING

FINAL REPORT

Prepared for:

U.S. ARMY ENGINEERING DISTRICT
SAN FRANCISCO CORPS OF ENGINEERS
San Francisco, California

Prepared by:

TOXSCAN, INC./ KINNETIC LABORATORIES, INC.
Watsonville, California

JUNE 1998

to-two grams of sediment were placed in a 500 mL flask to which 10 mL of potassium dichromate ($K_2CR_2O_7$) had been added. Twenty mL of concentrated sulfuric acid (H_2SO_4) was then added while the flask was swirled. After 30 minutes, the sample was diluted to a volume of 200 mL with de-ionized water (DIW), and 10 mL of phosphoric acid (H_3PO_4) and 0.2 g of sodium fluoride (NaF) were added. After more swirling, 15 drops of diphenylamine indicator was added and the sample was titrated with 0.5N ferrous ammonium sulfate.

Metals. Analyses for metals utilized combinations of the following Varian spectrophotometers: SpectrAA 400P or 400Z with GTA 96 a Graphite Furnace and autosampler; or a SpectrAA 10 with VOA 76 hydride—cold vapor generator and flame autosamplers. Sample preparation prior to analysis by atomic absorption was accomplished by guidelines specified by Chapter 3, Sections 3.2 and 3.3, 7000 series (USEPA 1986).

Chlorinated Pesticides and PCB's. Analyses for these constituents were determined by Method 8080A (USEPA 1992), which incorporates the updated procedures (but not the expanded analyte list) of Method 8081. A solid sample was mixed with anhydrous sodium sulfate, placed in an extraction thimble and extracted using acetone and hexane in a Soxhlet extractor. The extract was then dried, concentrated, and underwent a Florisil and mercury clean-up. The extract was analyzed by gas chromatograph with an electron capture detector.

Polynuclear Aromatic Hydrocarbons and Phthalates. Analyses for semivolatile compounds were by GC-MS techniques, following Method 8270B (USEPA 1992). A solid sample was mixed with anhydrous sodium sulfate and sonicated in methylene chloride. The extract was concentrated and then cleaned up by gel permeation chromatography. The extracted sample was analyzed by gas chromatograph/ mass spectroscopy. The USEPA 8270 method was modified slightly by the use of Varian Selective Ion Storage technique which eliminates interfering ions from the sample spectrum.

3.0 Results

Four sediment composite samples were collected from Noyo Harbor, prepared and analyzed. All individual core samples were archived.

Results of bulk sediment chemical and physical analyses of the Noyo Harbor sediment samples are summarized in **Table** 3. Detailed laboratory reports (including QA/QC) of chemistry analyses are presented in Appendix C. The project QA plan is contained in Appendix D; Chains of Custody are presented in Appendix E.

3.1 Sediment Grain Size Analysis

Particle size distributions (grain size) were determined for the four Noyo Harbor composite samples. The composites contained between 71% and 96% coarse sediments by weight ($\Phi \leq 4$).

3.2 Bulk Sediment Chemistry

Sediment Conventionals. The composites contained 73% to 79% solid materials and 0.22% to 0.82% TOC. Total sulfides ranged from 14 to 530 mg/Kg in the Harbor sediments; water soluble sulfides ranged from 1.0 mg/Kg to 4.6

mg/Kg. Oil and Grease (hexane extractable compounds) concentrations ranged from <100 mg/Kg to 160 mg/Kg; TRPH was <100 mg/Kg in each of the composites. Total volatile solids ranged from 2.0 to 4.5 mg/Kg.

Metals. The Noyo Harbor sediment composites were analyzed for seventeen metals. Within the harbor composites, metals concentrations were generally similar in composites 1, 3 and 4, with lower values usually found in Comp 2. Ranges (mg/Kg, dry weight) are as follows:

	Min	Max		Min	Max
Antimony	ND	ND	Mercury	0.07	0.09
Arsenic	2.20	2.90	Molybdenum	0.11	0.31
Barium	69.00	130.00	Nickel	22.00	33.00
Beryllium	0.54	0.71	Selenium	ND	ND
Cadmium	ND	0.15	Silver	0.11	0.31
Chromium	34.00	46.00	Thallium	0.11	0.28
Cobalt	8.10	11.00	Vanadium	33.00	52.00
Copper	14.00	34.00	Zinc	46.00	70.00
Lead	5.30	9.10			

Chlorinated Pesticides and PCBs. The Noyo Harbor sediments were analyzed for twenty-one chlorinated pesticides and four polychlorinated biphenyls (PCBs as Aroclors). No pesticides or PCBs were detected in the composites.

Semivolatiles. Eighteen polynuclear aromatic hydrocarbons (PAHs) were measured in the Noyo Harbor sediments. Total PAH concentrations ranged from 11 ppb (Comp 2) to 930 ppb (Comp 1).

4.0 SUMMARY EVALUATION

The sediments tested in this project were relatively coarse - grained, with low levels of organic carbon, dissolved sulfides and hexane-extractable compounds; petroleum hydrocarbons were not detected. With the exception of barium, which was found at ≥100 mg/Kg dry wt in two of the composites, Title 22 metals were found only in trace amounts. Organochlorine pesticides were not detected in the sediments, and PAH concentrations were below 1 mg/Kg.

Table 3. Bulk Sediment Chemistry Summary: Noyo Harbor FY1998 Maintenance Dredging.

Analyte	COMP1	COMP 2	COMP 3	COMP 4	Reporting Limits Target (PN 93-2)	Reporting Limits Achieved#
GRAIN SIZE (% dry)						
Sand/Gravel (>0.063 mm)	71.1	95.9	83.3	85.1	NA	--
Silt (0.004 mm - 0.063 mm)	24.1	2.9	13.6	12.2	NA	--
Clay (<0.004 mm)	4.8	1.2	3.1	2.6	NA	--
SEDIMENT CONVENTIONALS						
Total sulfides (mg/Kg, dry)	530	14	310	330	0.10	0.10
Total Volatile Solids (%)	4.5	2.0	4.3	3.1	0.10	0.10
Water soluble sulfides (mg/Kg, dry)	1.7	1.0	4.6	1.8	0.10	0.10
Oil and Grease*	150	ND	160	140	20	100
TRPH** (mg/Kg, dry)	ND	ND	ND	ND	20	100
% Solids (%)	73	79	73	77	0.10	0.10
TOC (%)	0.59	0.22	0.82	0.62	0.10	0.10
METALS (mg/Kg, dry wt)						
Antimony	ND	ND	ND	ND	--	0.10
Arsenic	2.70	2.20	2.50	2.90	0.10	0.10
Barium	130.00	97.00	69.00	100.00	--	0.10
Beryllium	0.68	0.54	0.67	0.71	--	0.10
Cadmium	0.11	ND	0.15	0.15	0.10	0.10
Chromium	46.00	34.00	46.00	46.00	0.10	0.10
Cobalt	10.00	8.10	9.20	11.00	--	0.10
Copper	22.00	14.00	19.00	34.00	0.10	0.10
Lead	8.30	5.30	9.00	9.10	0.10	0.10
Mercury	0.08	0.07	0.07	0.09	0.02	0.02
Molybdenum	0.23	0.11	0.24	0.31	--	0.10
Nickel	33.00	22.00	28.00	31.00	0.10	0.10
Selenium	ND	ND	ND	ND	0.10	0.10
Silver	0.18	0.17	0.31	0.11	0.10	0.10
Thallium	0.17	0.11	0.28	0.15	--	0.10
Vanadium	46.00	33.00	46.00	52.00	--	0.10
Zinc	66.00	46.00	60.00	70.00	1.0	1.0

(Continued...)

Table 3. Bulk Sediment Chemistry Summary: Noyo Harbor FY1998 Maintenance Dredging

Analyte	COMP 1	COMP 2	COMP 3	COMP 4	Reporting Limits Target (PN 93-2)	Reporting Limits Achieved#
CHLORINATED PESTICIDES (µg/kg, dry						
Aldrin	ND	ND	ND	ND	2.0	1.3-1.4
alpha-BHC	ND	ND	ND	ND	2.0	1.3-1.4
beta-BHC	ND	ND	ND	ND	2.0	1.3-1.4
delta-BHC	ND	ND	ND	ND	2.0	1.3-1.4
gamma-BHC (lindane)	ND	ND	ND	ND	2.0	1.3-1.4
alpha-Chlordane	ND	ND	ND	ND	2.0	1.3-1.4
gamma-Chlordane	ND	ND	ND	ND	2.0	1.3-1.4
4,4'-DDD	ND	ND	ND	ND	2.0	1.3-1.4
4,4'-DDE	ND	ND	ND	ND	2.0	1.3-1.4
4,4'-DDT	ND	ND	ND	ND	2.0	1.3-1.4
∑ DDT	--	--	--	--	--	--
Dieldrin	ND	ND	ND	ND	2.0	1.3-1.4
Endosulfan I	ND	ND	ND	ND	2.0	1.3-1.4
Endosulfan II	ND	ND	ND	ND	2.0	1.3-1.4
Endosulfan sulfate	ND	ND	ND	ND	2.0	1.3-1.4
Endrin	ND	ND	ND	ND	2.0	1.3-1.4
Endrin Aldehyde	ND	ND	ND	ND	2.0	1.3-1.4
Endrin Ketone	ND	ND	ND	ND	2.0	1.3-1.4
Heptachlor	ND	ND	ND	ND	2.0	1.3-1.4
Heptachlor epoxide	ND	ND	ND	ND	2.0	1.3-1.4
Methoxychlor	ND	ND	ND	ND	2.0	1.3-1.4
Toxaphene	ND	ND	ND	ND	30***	19-21
PCBs (µg/kg, dry weight)						
PCB 1242	ND	ND	ND	ND	20	13-14
PCB 1248	ND	ND	ND	ND	20	13-14
PCB 1254	ND	ND	ND	ND	20	13-14
PCB 1260	ND	ND	ND	ND	20	13-14
∑PCBs	--	--	--	--	--	--

(Continued...)

Table 3. Bulk Sediment Chemistry Summary: Noyo Harbor FY1998 Maintenance Dredging.

Analyte	COMP 1	COMP 2	COMP 3	COMP 4	Reporting Limits Target (PN93-2)	Reporting Limits Achieved#
SEMI-VOLATILES (µg/kg, dry wt)						
Naphthalene	ND	ND	36	ND	20	9.5-10
2-Methylnaphthalene	ND	ND	17	ND	20	9.5-10
2-Chloronaphthalene	ND	ND	ND	ND	20	9.5-10
Acenaphthylene	ND	ND	ND	ND	20	9.5-10
Acenapthene	25	ND	26	ND	20	9.5-10
Fluorene	36	ND	22	ND	20	9.5-10
Phenanthrene	210	ND	91	34	20	9.5-10
Anthracene	16	ND	ND	15	20	9.5-10
Fluroanthene	250	ND	47	88	20	9.5-10
Pyrene	210	11	39	140	20	9.5-10
Benzo(a)anthracene	41	ND	13	72	20	9.5-10
Chrysene	62	ND	17	97	20	9.5-10
Benzo(b)fluoranthene	30	ND	ND	70	20	9.5-10
Benzo(k)fluoranthene	30	ND	ND	66	20	9.5-10
Benzo(a)pyrene	23	ND	ND	54	20	9.5-10
Indeno[1,2,3-CD]pyrene	ND	ND	ND	27	20	13-14
Dibenzo(a,h)anthracene	ND	ND	ND	ND	20	13-14
Benzo[ghi]perylene	ND	ND	ND	21	20	13-14
∑ detectable LPAHs	280	--	190	50	--	--
∑ detectable HPAHs	650	11	120	640	--	--
∑ detectable PAHs	930	11	310	680	--	--
Dimethyphthalate	ND	ND	36	ND	20	9.5-10
Diethylhthalate	13	ND	ND	ND	20	9.5-10
Di-n-butylphthalate	36	40	25	28	20	9.5-10
Butyl benzyl phthalate	ND	ND	ND	ND	20	9.5-10
Bis(2-ethylhexyl)phthalate	410	30	56	790	20	9.5-10
Di-n-octylphthalate	ND	ND	37	ND	20	9.5-10
∑ phthalate esters	460	70	150	820	--	--

-- Not Applicable # Achieved Reporting Limits increase in sediments with >50% moisture.
* Hexane-extractable. ** Silica gel extractable from Oil and Grease extractant. ***Toxaphene achievable Reporting Limit.